TWP-ICE - Summary and model study implications

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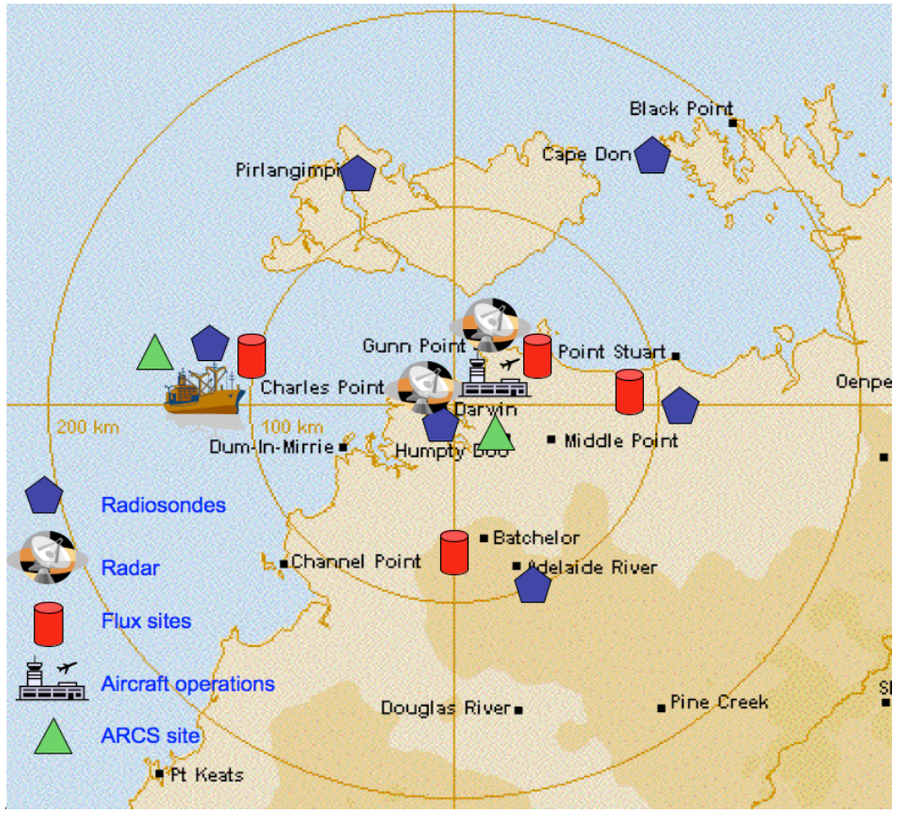
Peter May (BMRC) and Jim Mather (PNNL)

TWP-ICE setup

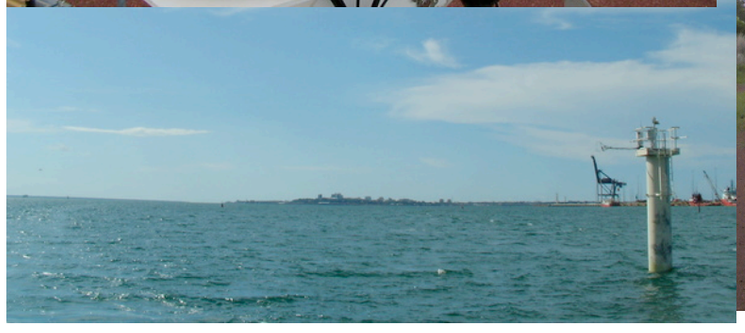


- Extensive ground-based network
  - >1000 three-hourly radiosondes at 5 sites
  - Ship
  - radars, lidars, radiometers, ...
- 5 research aircraft
- 150 participants

Ground based observations:

3D cloud structure from Polarimetric and Doppler radar
Profiles of clouds at 4 sites (ARM, Profiler, C-Pol and Ship)
Radiative flux measurements at multiple sites
Surface fluxes at 4 land sites and ship
3 hrly soundings from circle of 5 sites and 6hrly at Darwin
Wind profilers at 2 sites
Temp/humidity profilers at ARM site

~ 1050 sondes
2 by 3500 radar volumes
5-10 sec cloud profiles at 3 sites
1 min sampling of w at 2 sites
+satellite and NWP



Cape Don

Mt Bundy

Fogg dam

Pirlangimpi

CDU

RFC

CDU briefing

RV Southern Surveyor

24 day cruise as floating ARM site

Radiosondes every 3 hours
Surface sensible, latent heat fluxes
Radiative fluxes
95 GHz cloud radar (6 sec res)
Lidar

Buoys
Sea-soar
CDT

Aircraft strategies

Twin Otter flying below high altitude aircraft
High altitude aircraft stacked, cross-sections and spirals thru' clouds

Dornier sampling BL environment and inflow

Dimona measuring surface fluxes and BL structure

Coordinated from "control centre" at RFC

More than 20 missions

4 flux over ship, 5 over land, 1 survey

Several BL structure missions including recovery after convection

3 monsoon and 3 break thick anvil

4 cirrus missions

3 satellite validation missions

Spirals over ground sites for validation of ground remote sensor retrievals

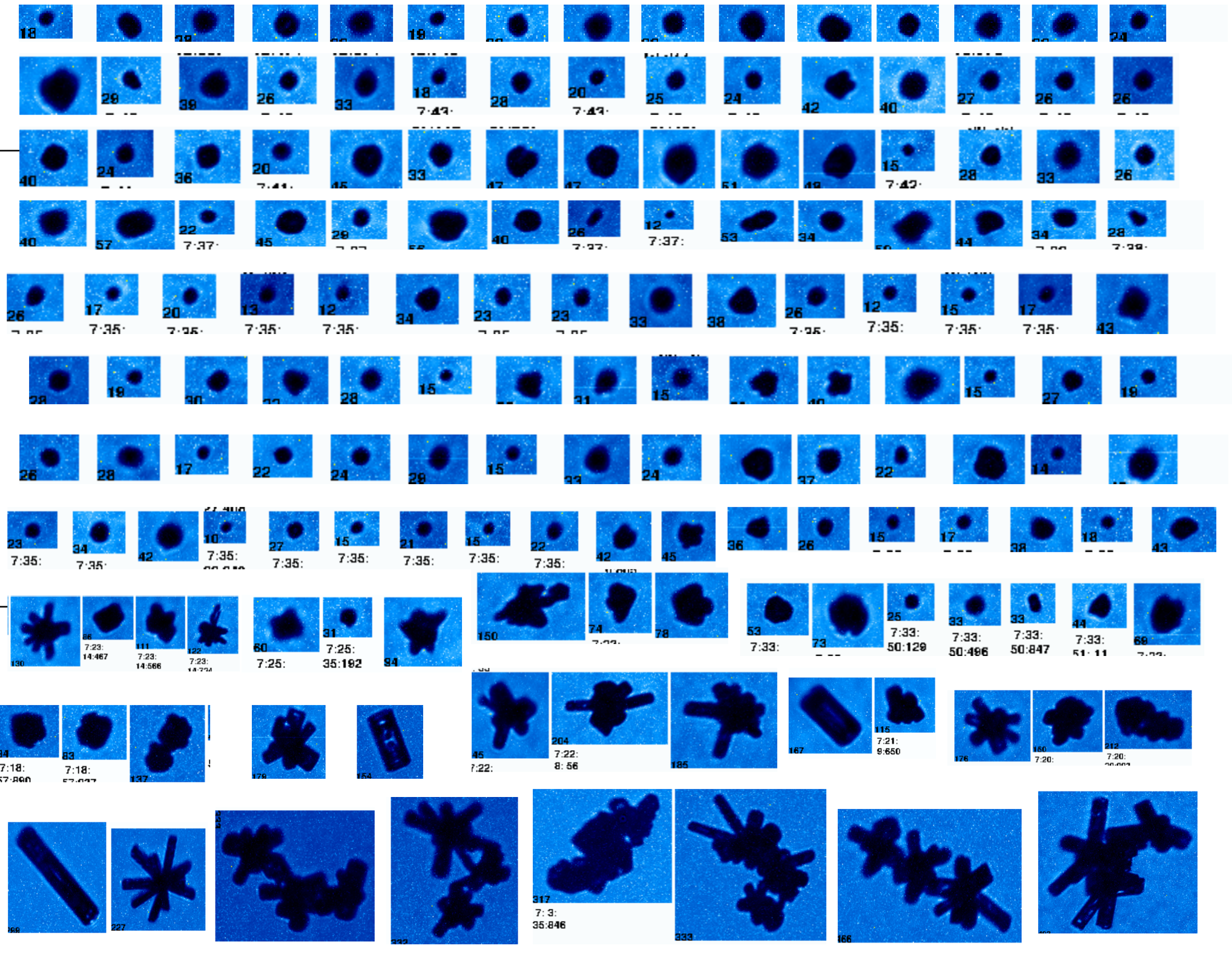
Several surveys

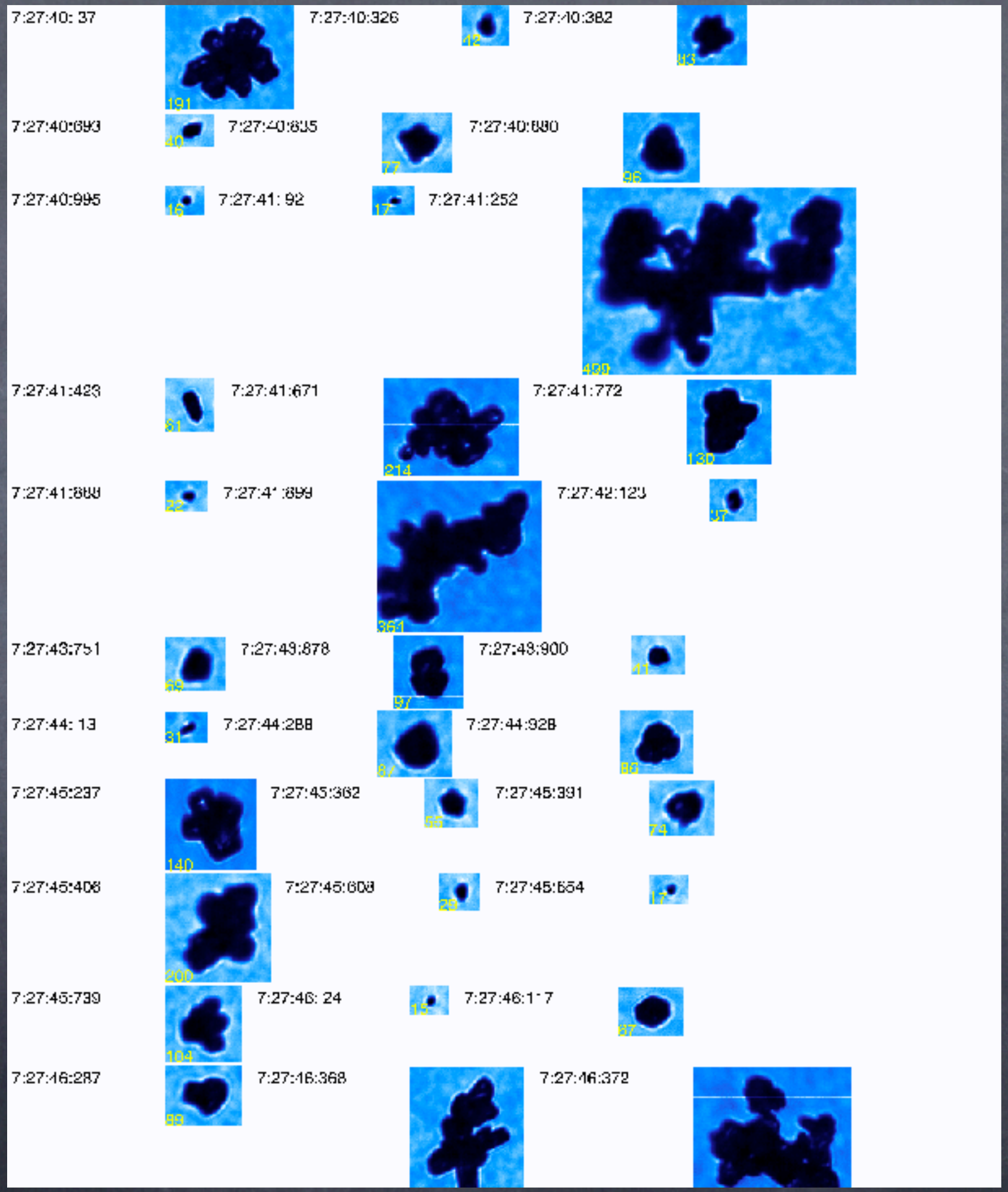
07:02:57 – 07:50:00

Height (km)

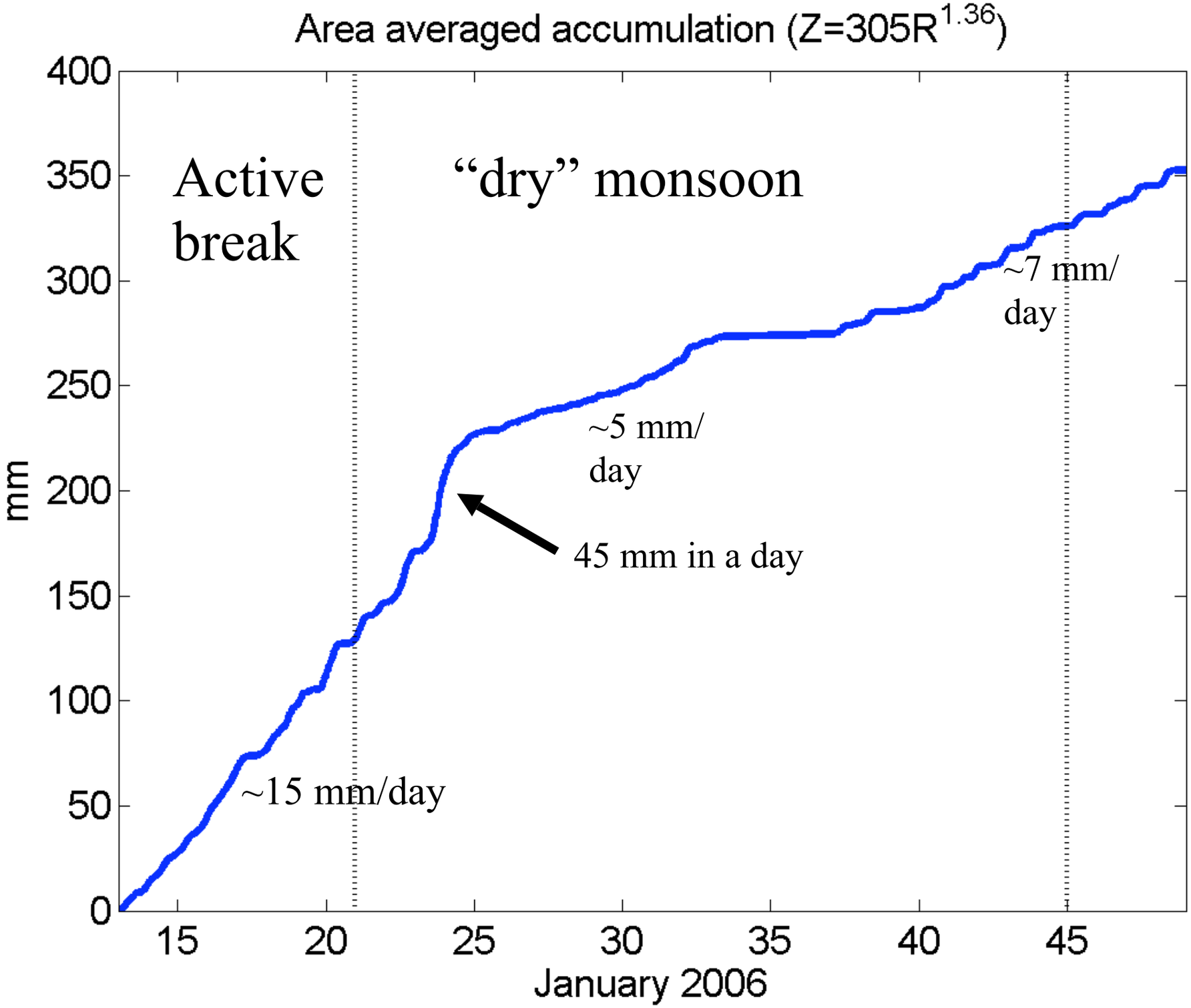
15

14

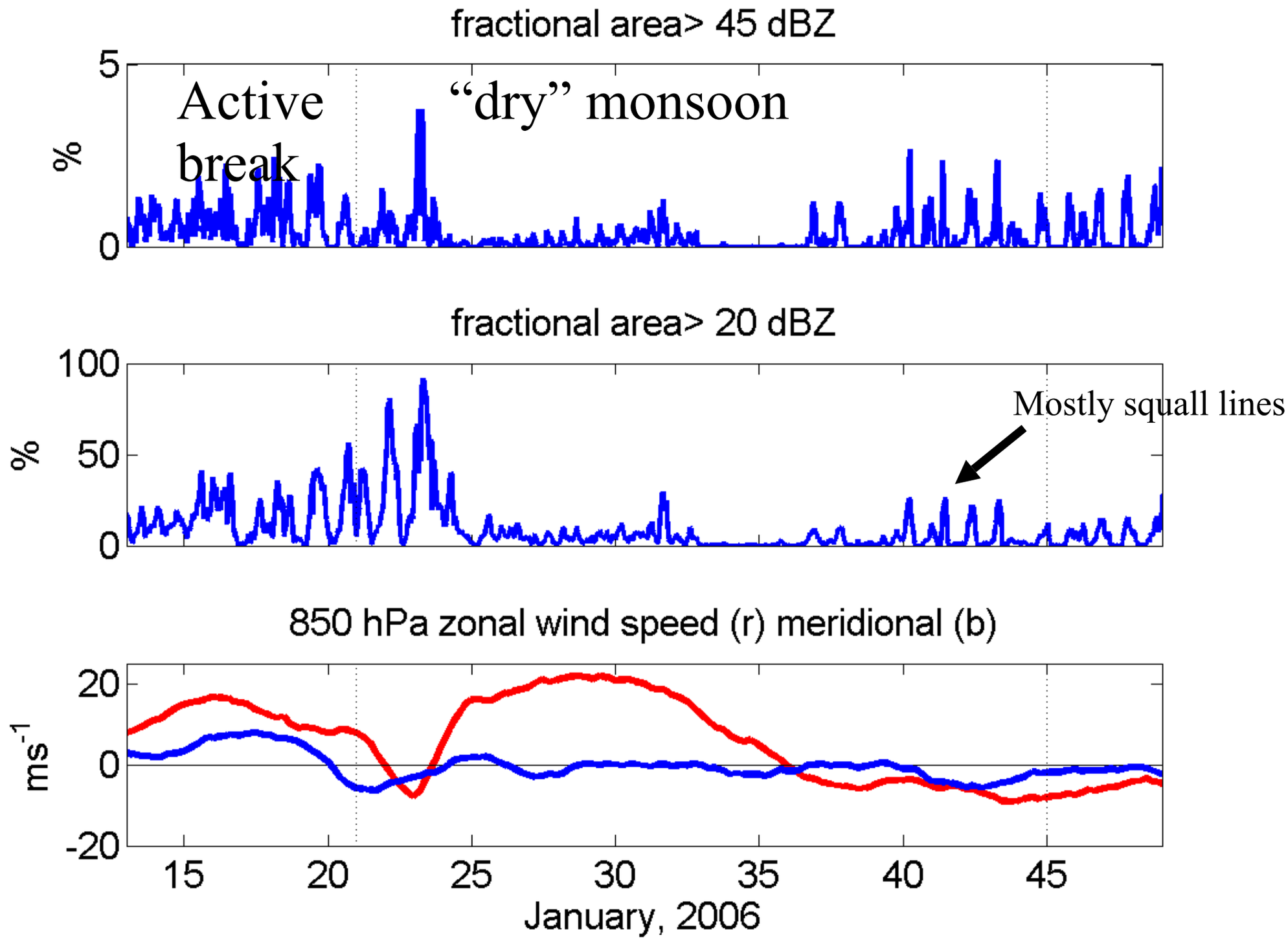



7:27:40: 37
191
7:27:40:326
42
7:27:40:382
83
7:27:40:693
40
7:27:40:835
77
7:27:40:880
96
7:27:40:995
16
7:27:41: 92
17
7:27:41:252
499
7:27:41:423
61
7:27:41:671
214
7:27:41:772
130
7:27:41:869
22
7:27:4' :899
361
7:27:42:123
37
7:27:43:751
69
7:27:43:878
97
7:27:43:900
41
7:27:44: 13
31
7:27:44:288
87
7:27:44:928
86
7:27:45:237
140
7:27:45:362
55
7:27:45:391
74
7:27:45:408
200
7:27:45:608
28
7:27:45:654
17
7:27:45:739
104
7:27:46: 24
15
7:27:46:1' 7
87
7:27:46:287
93
7:27:46:368
7:27:46:372

What we had

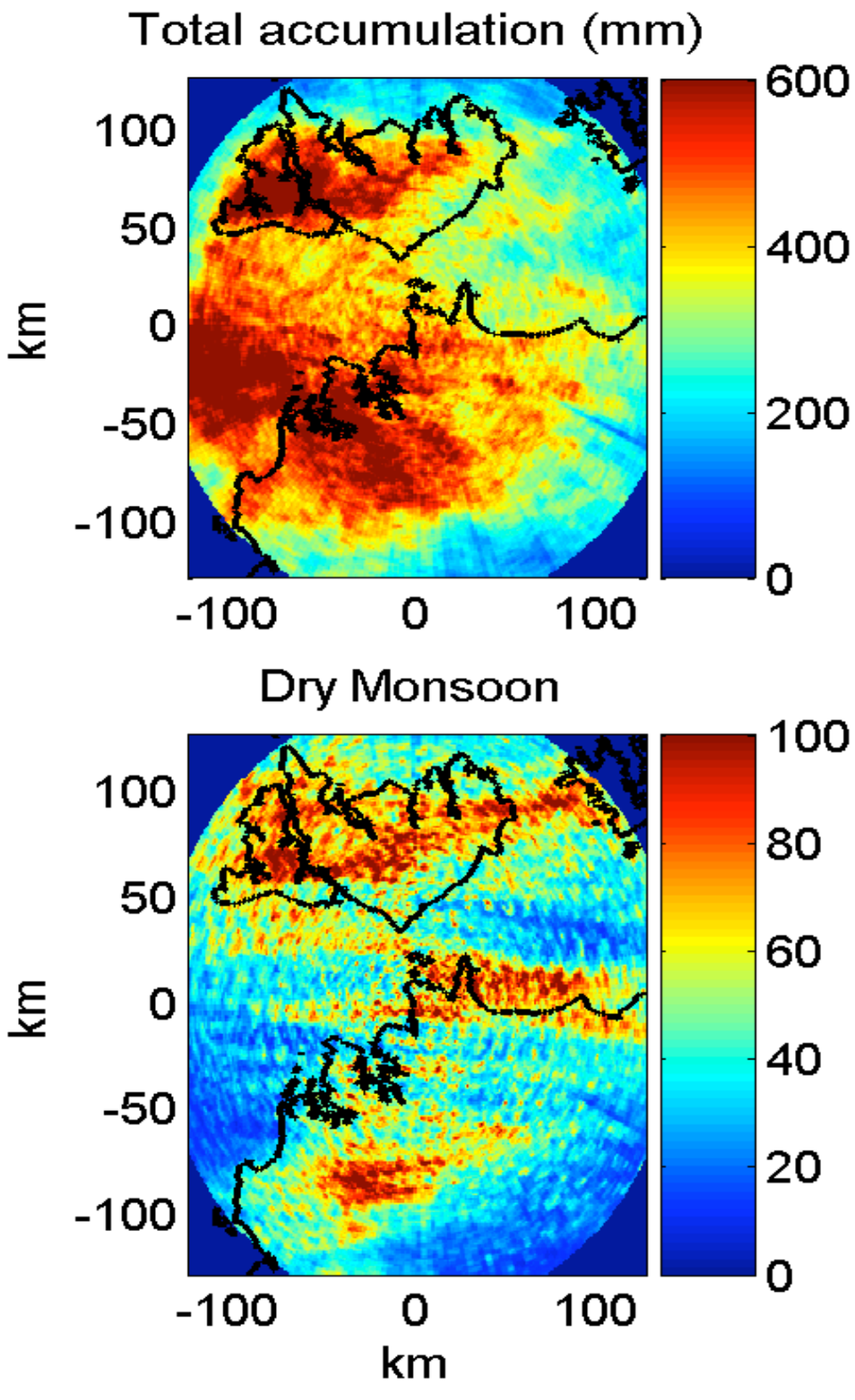

Area averaged accumulation (Z=305R^1.36)
Active break
"dry" monsoon
~7 mm/ day
~5 mm/ day
45 mm in a day
~15 mm/day
mm
400
350
300
250
200
150
100
50
0
15
20
25
30
35
40
45
January 2006

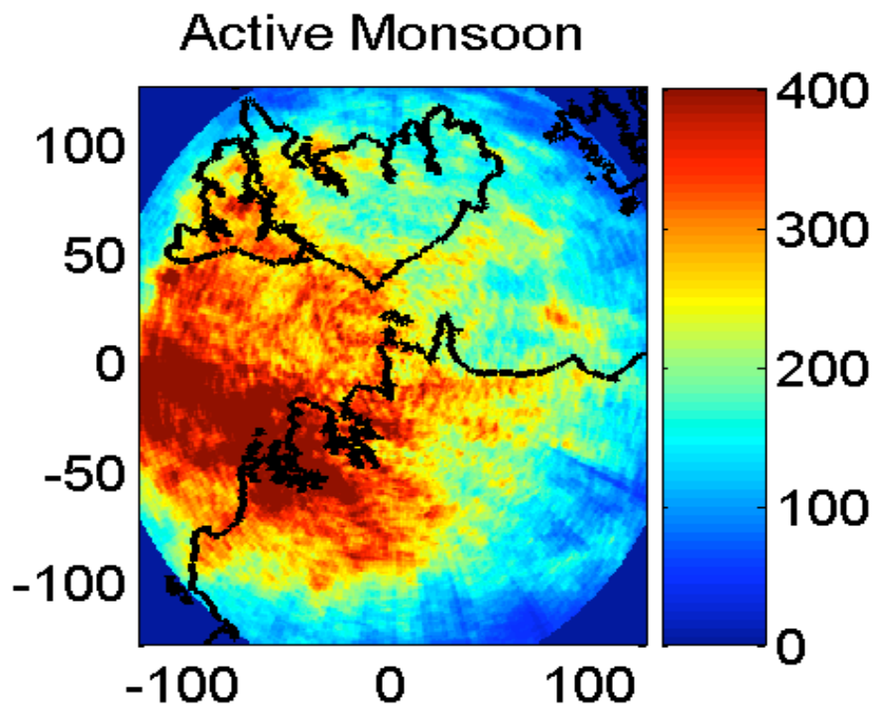
What we had

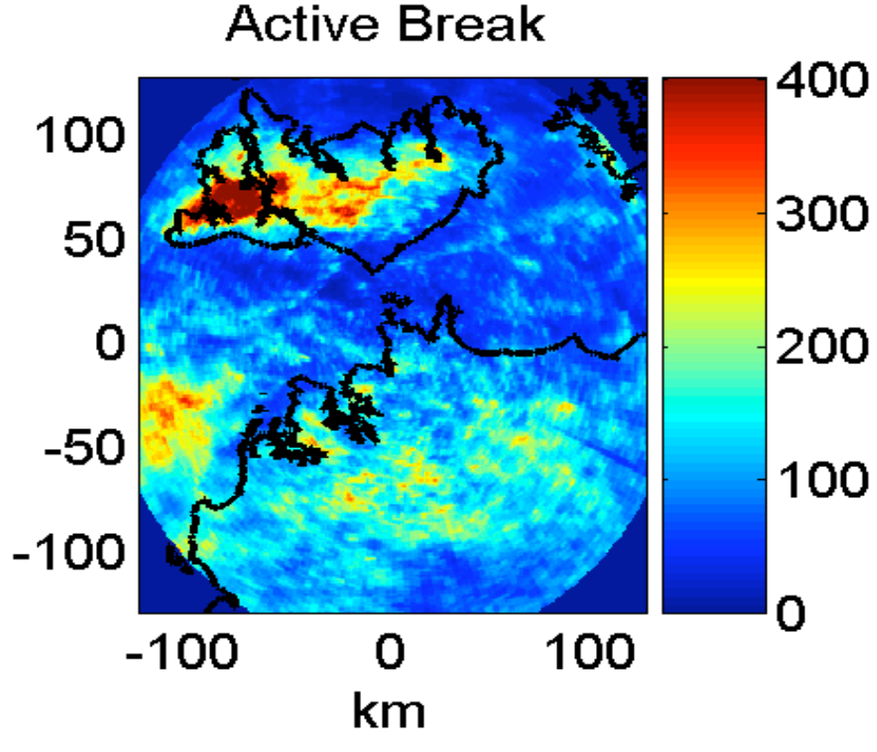

fractional area> 45 dBZ
5
%
0
Active break
"dry" monsoon
fractional area> 20 dBZ
100
%
50
0
Mostly squall lines
850 hPa zonal wind speed (r) meridional (b)
20
ms-1
0
-20
15
20
25
30
35
40
45
January, 2006

Spatial distribution (just adding up cappis) Z=305

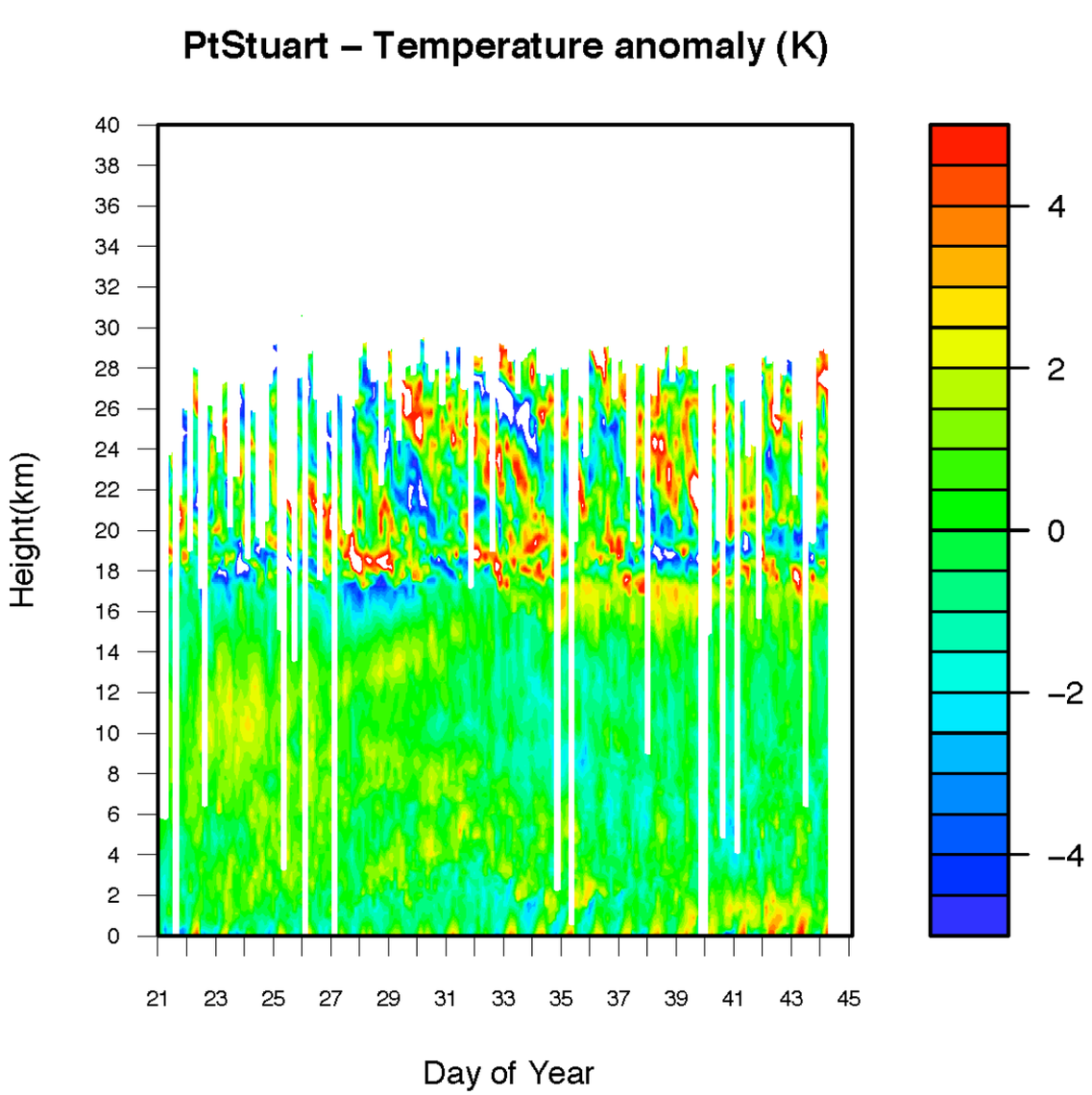
R1.36

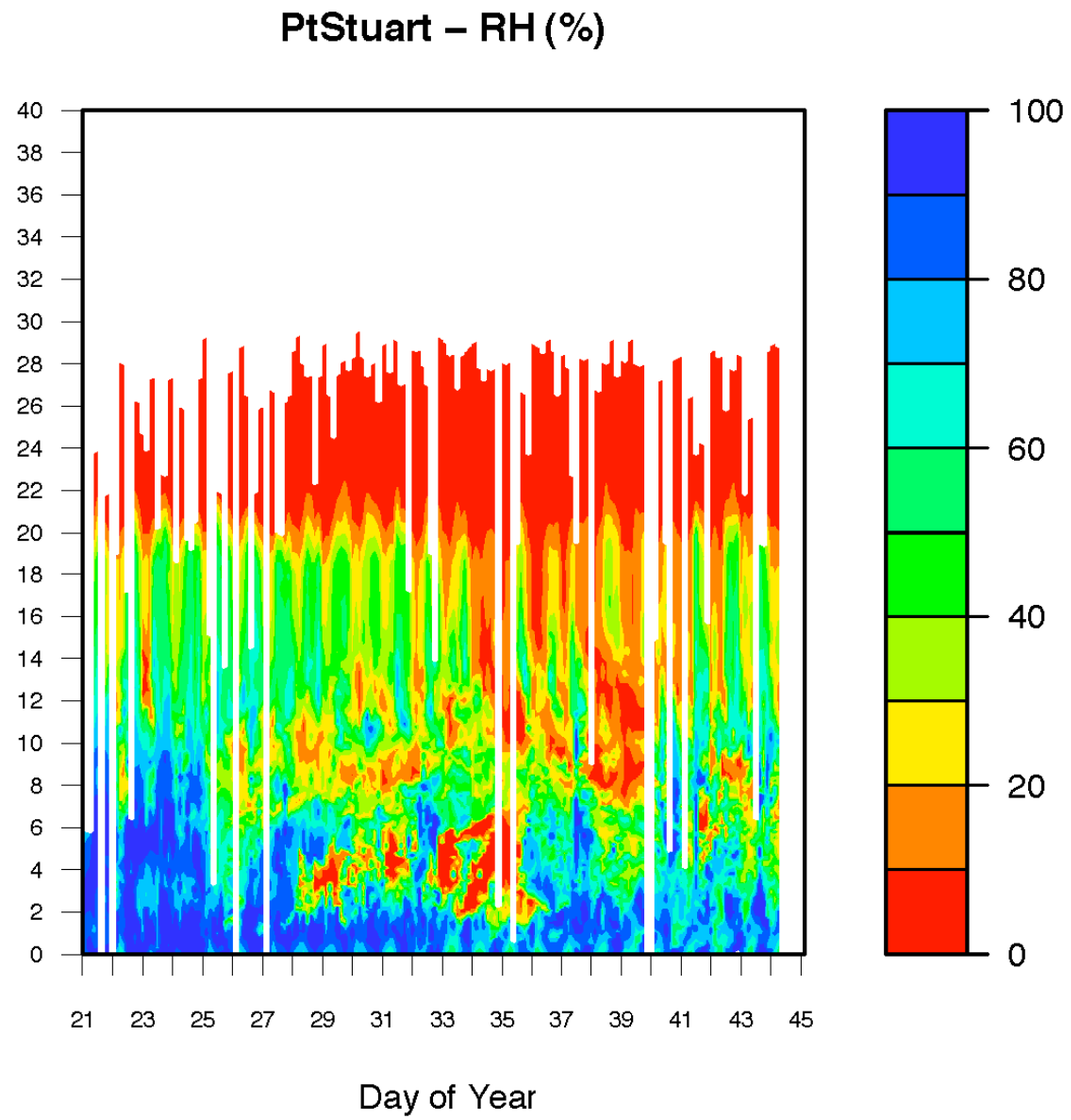




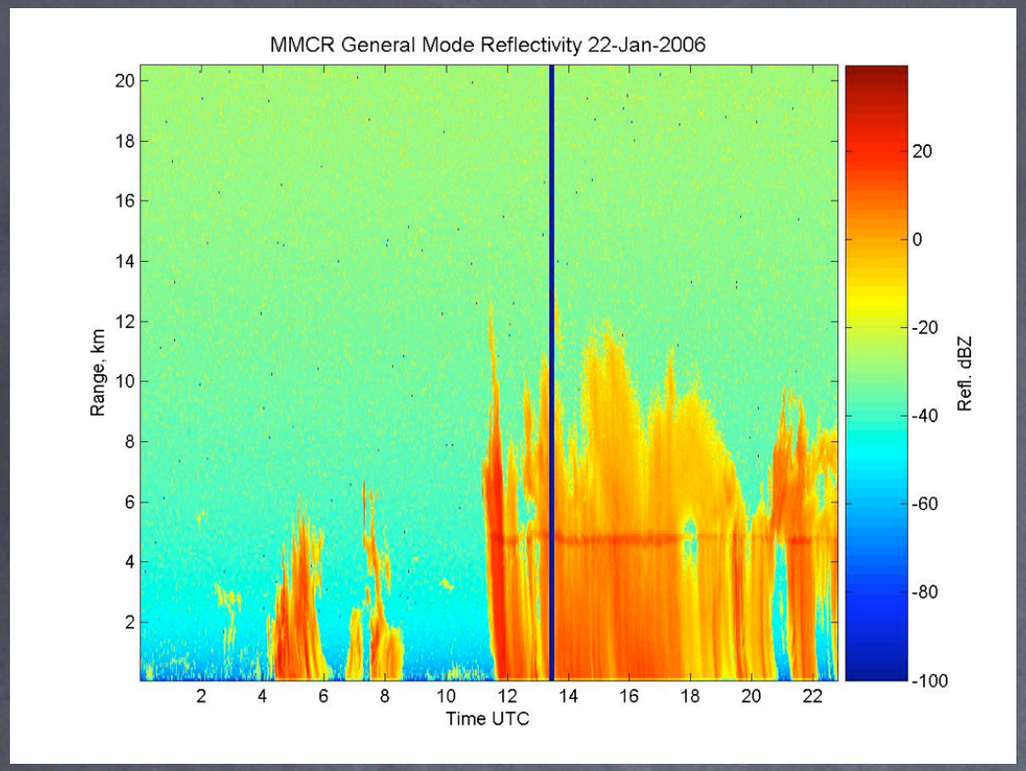


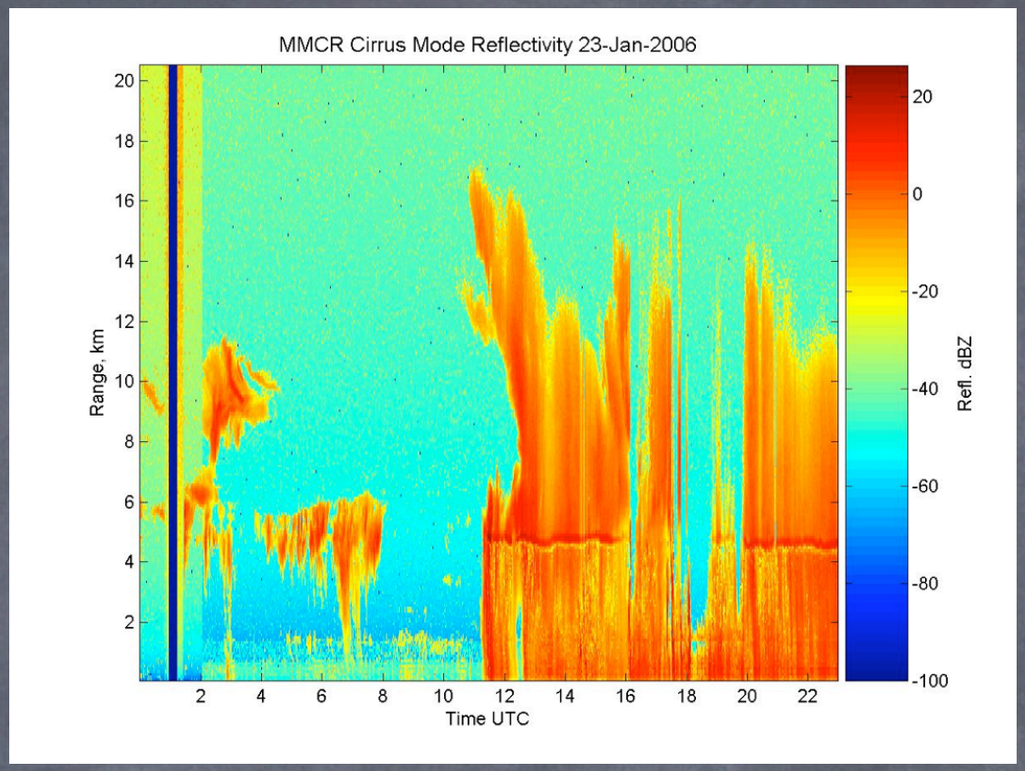
3 hourly soundings from Point Stuart
Warming (low)/ cooling (mid) and dryings through middle period
BL diurnal cycle of temperature increasing in magnitude
Stratospheric waves

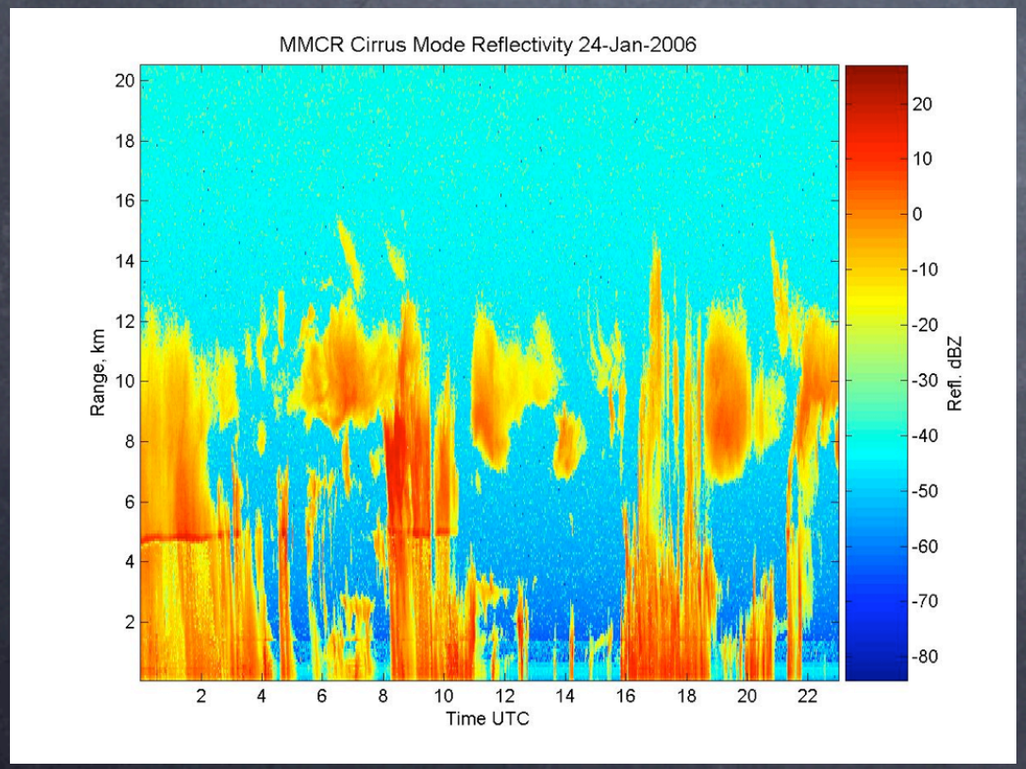


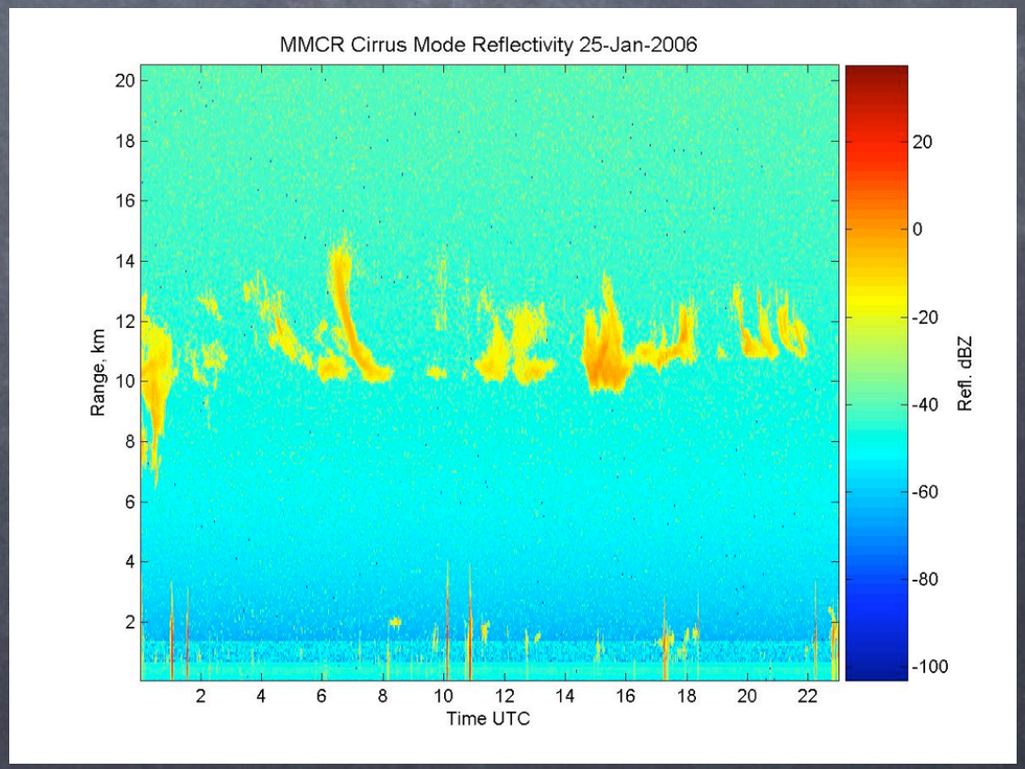


Monsoon

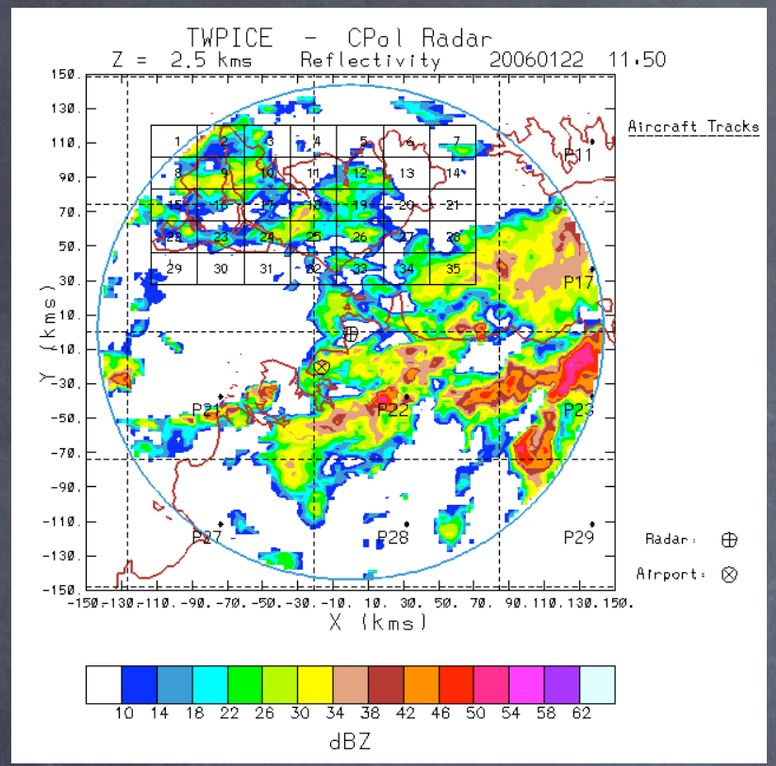

MMCR General Mode Reflectivity 22-Jan-2006
Range, km
Time UTC
Refl. dBZ

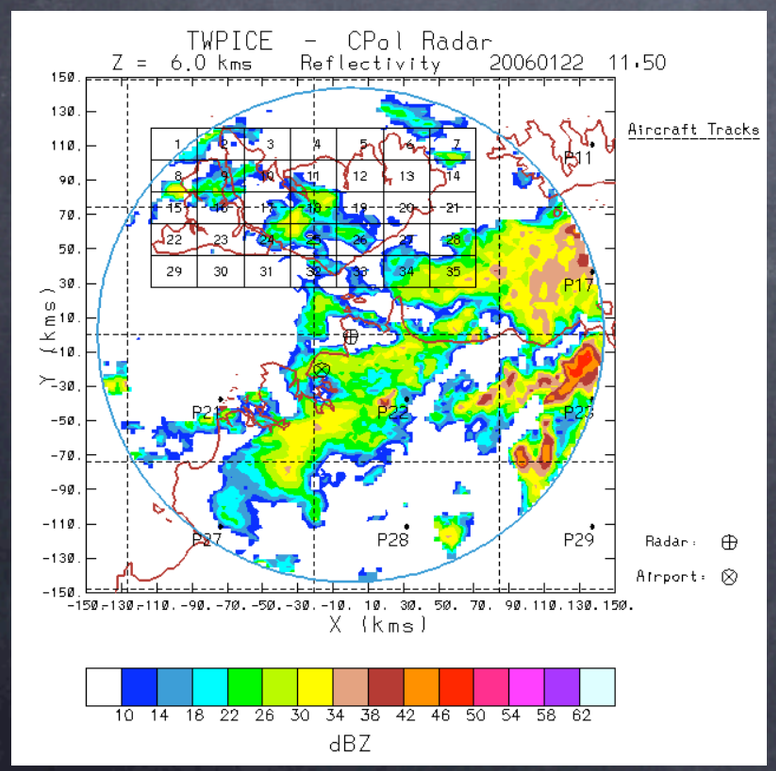

MMCR Cirrus Mode Reflectivity 23-Jan-2006
Range, km
Time UTC
Refl. dBZ

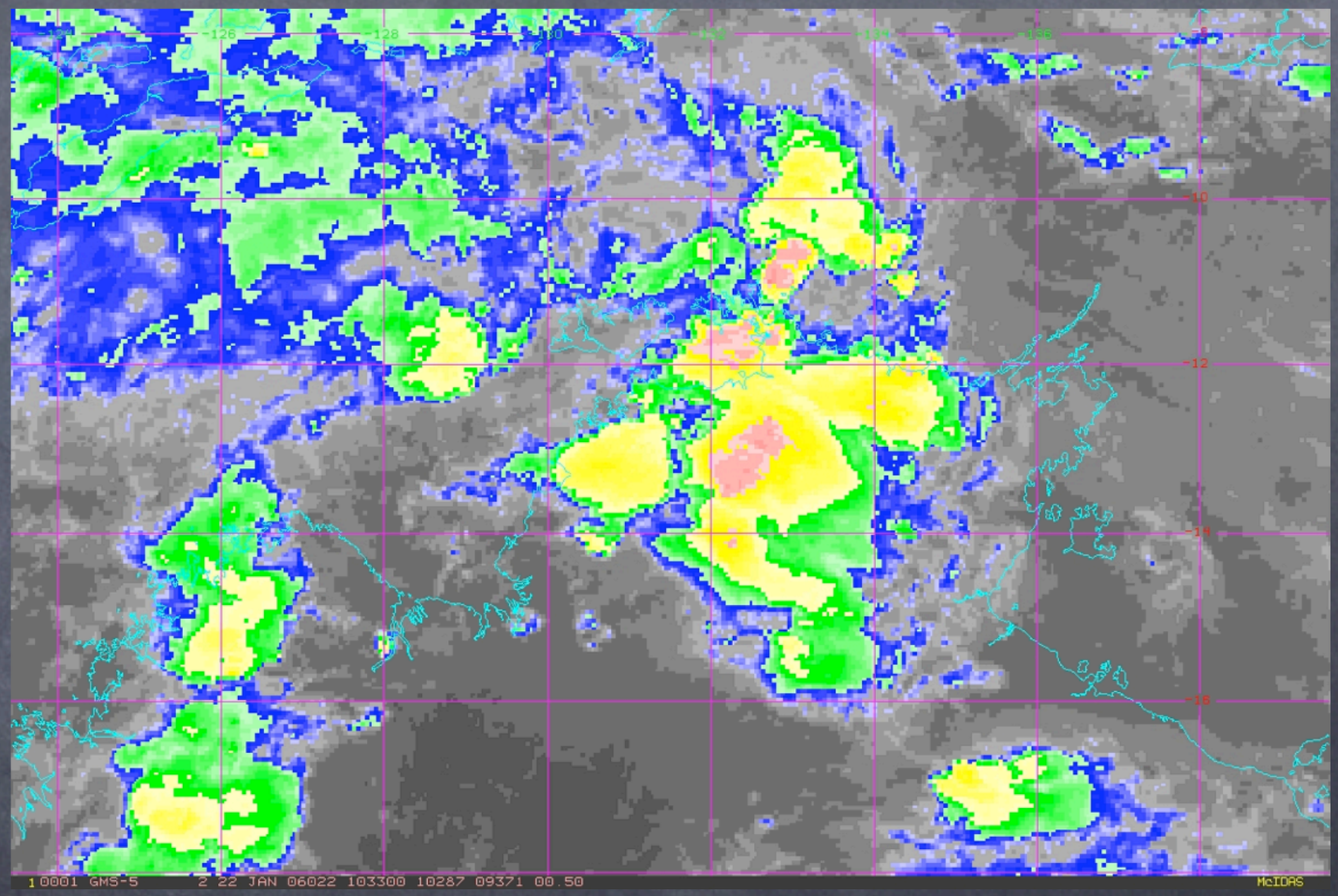

MMCR Cirrus Mode Reflectivity 24-Jan-2006
Range, km
Time UTC
Refl. dBZ


MMCR Cirrus Mode Reflectivity 25-Jan-2006
Range, km
Time UTC
Refl. dBZ

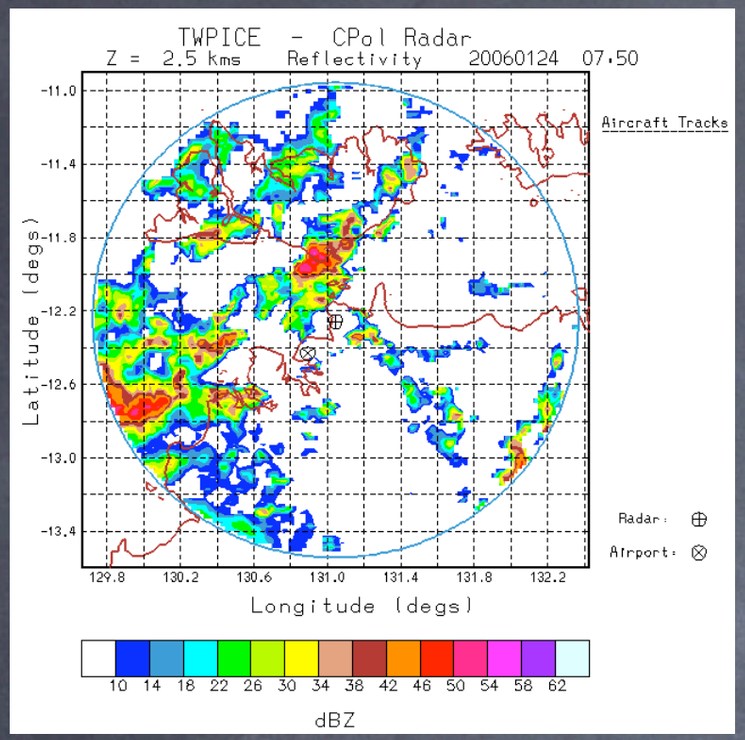
22 January - 12 UTC

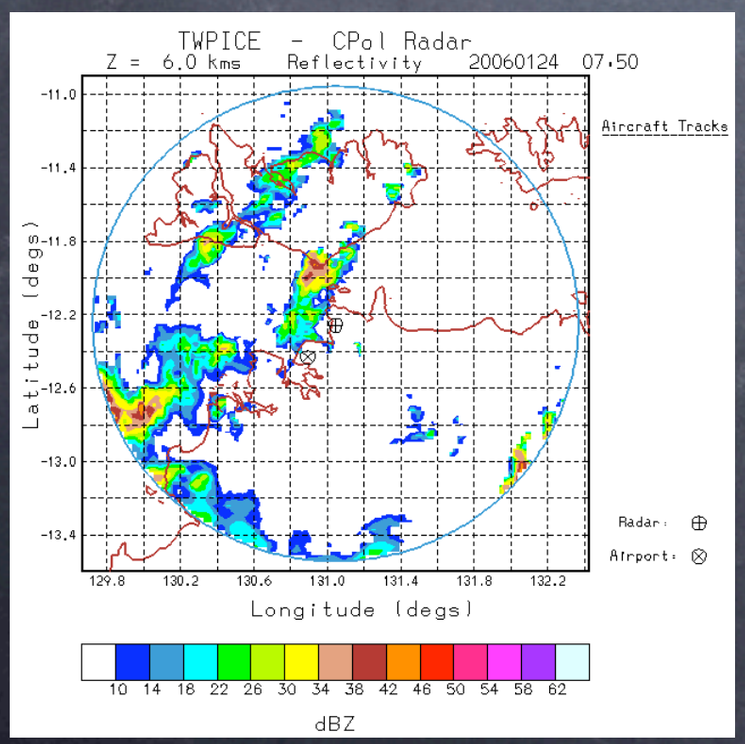


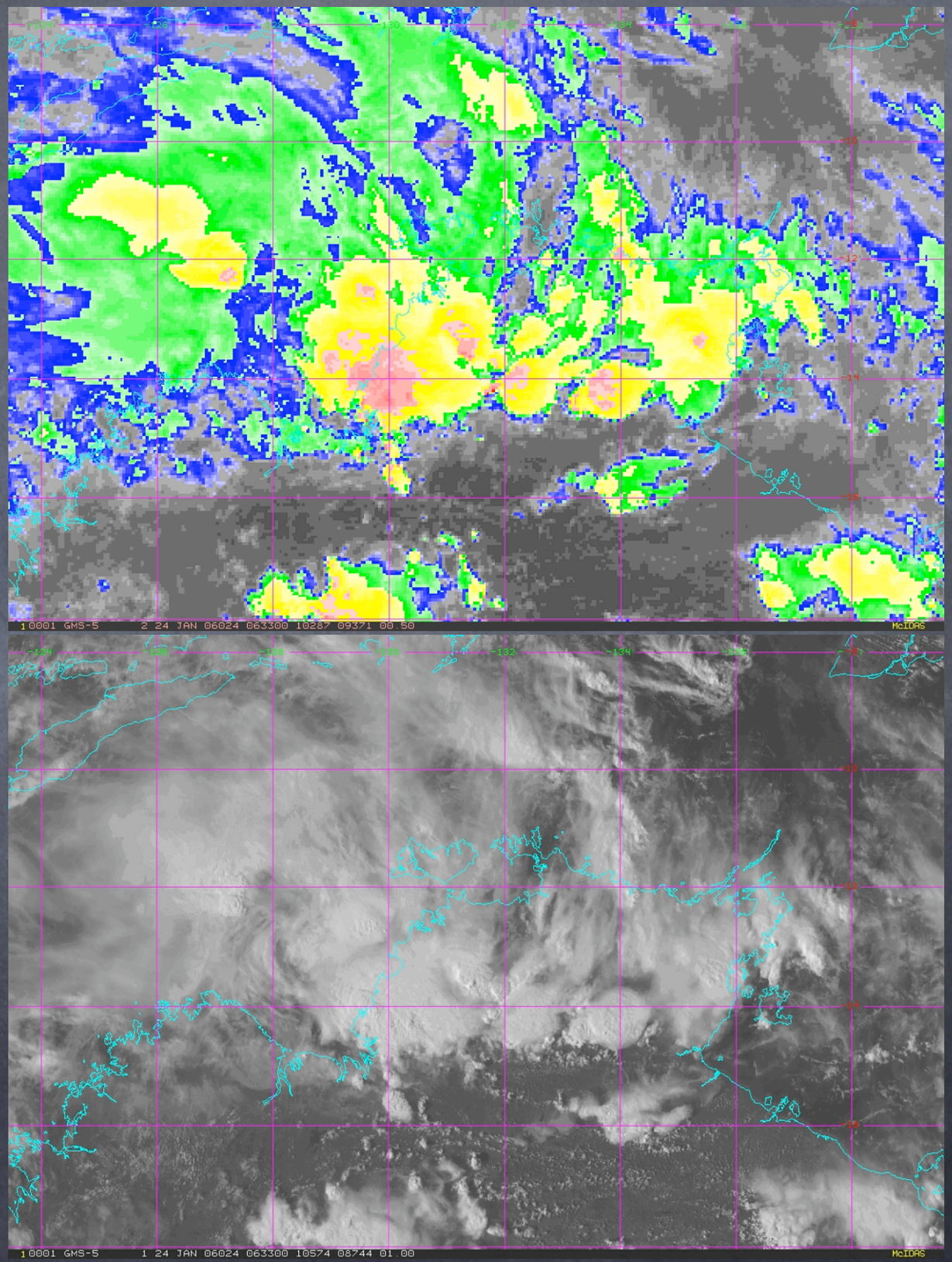




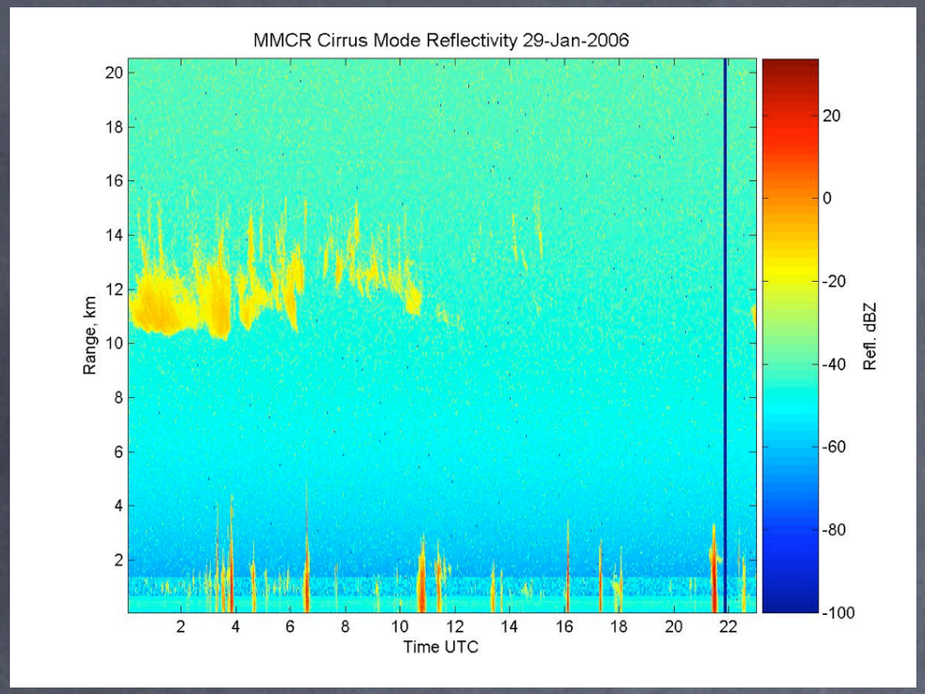
24 January - 8 UTC

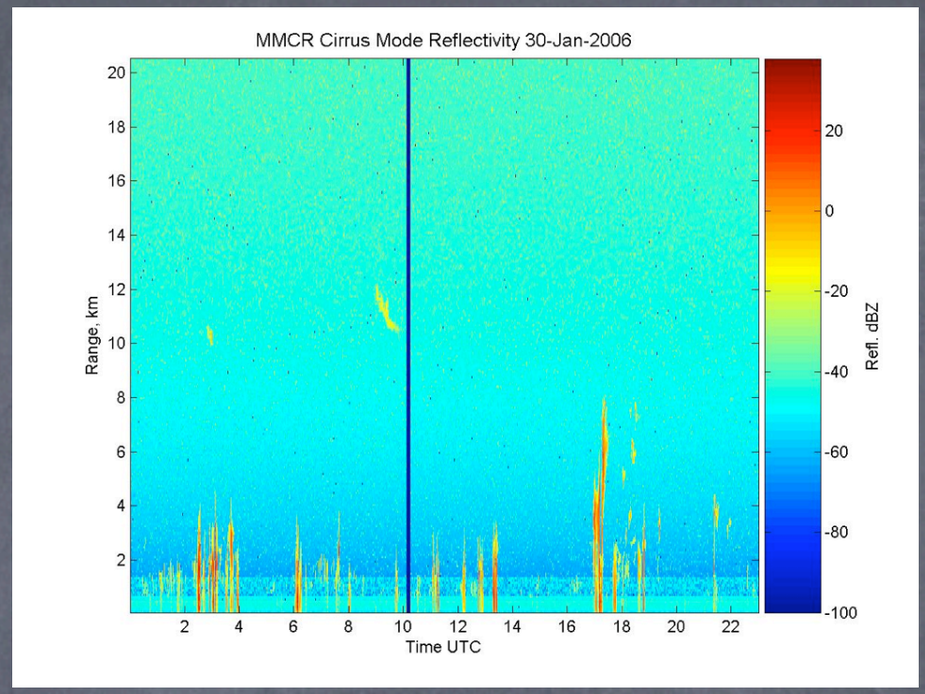


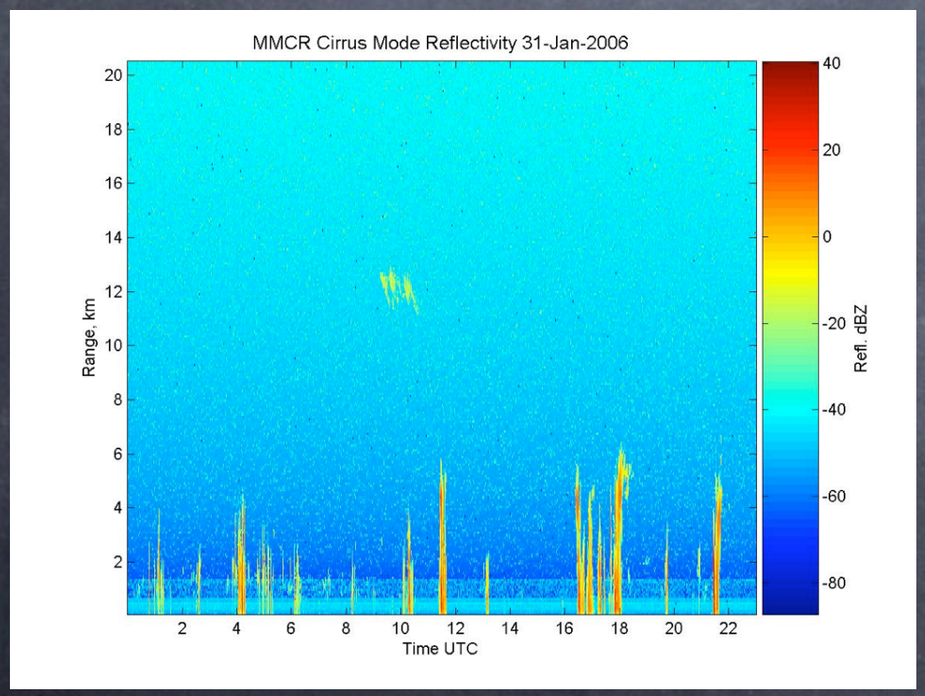


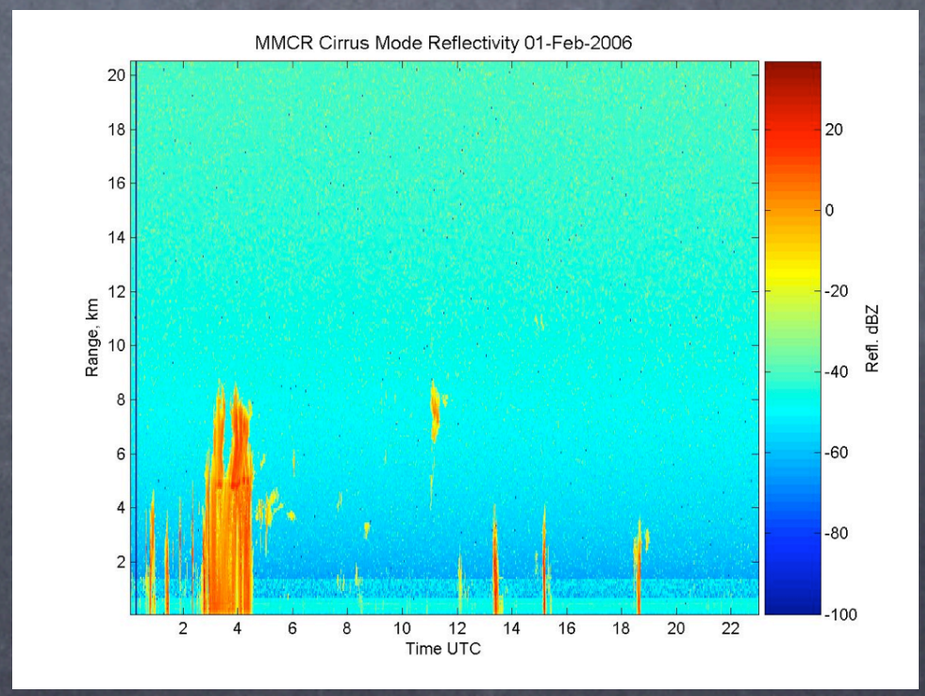


Dry Monsoon


MMCR Cirrus Mode Reflectivity 29-Jan-2006
Range, km
Time UTC
Refl. dBZ


MMCR Cirrus Mode Reflectivity 30-Jan-2006
Range, km
Time UTC
Refl. dBZ

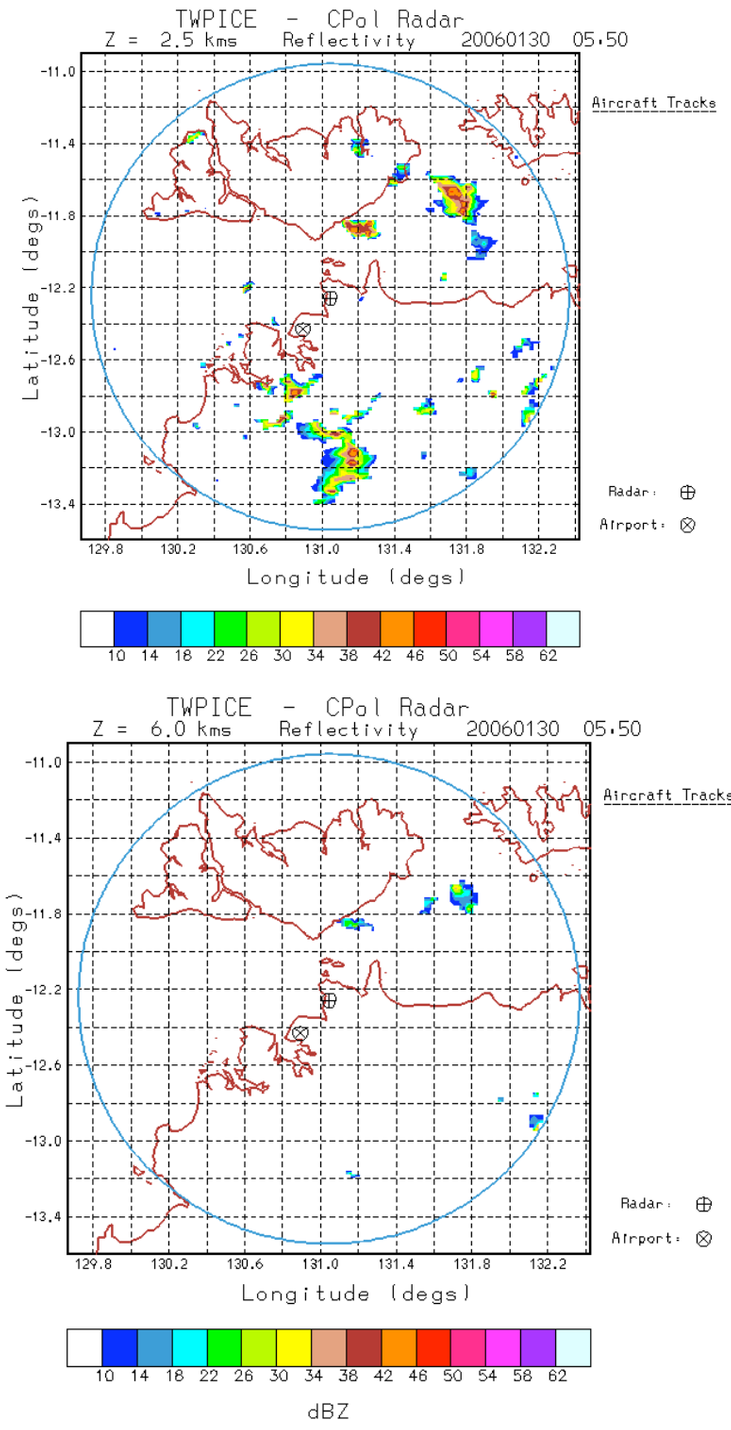

MMCR Cirrus Mode Reflectivity 31-Jan-2006
Range, km
Time UTC
Refl. dBZ


MMCR Cirrus Mode Reflectivity 01-Feb-2006
Range, km
Time UTC
Refl. dBZ

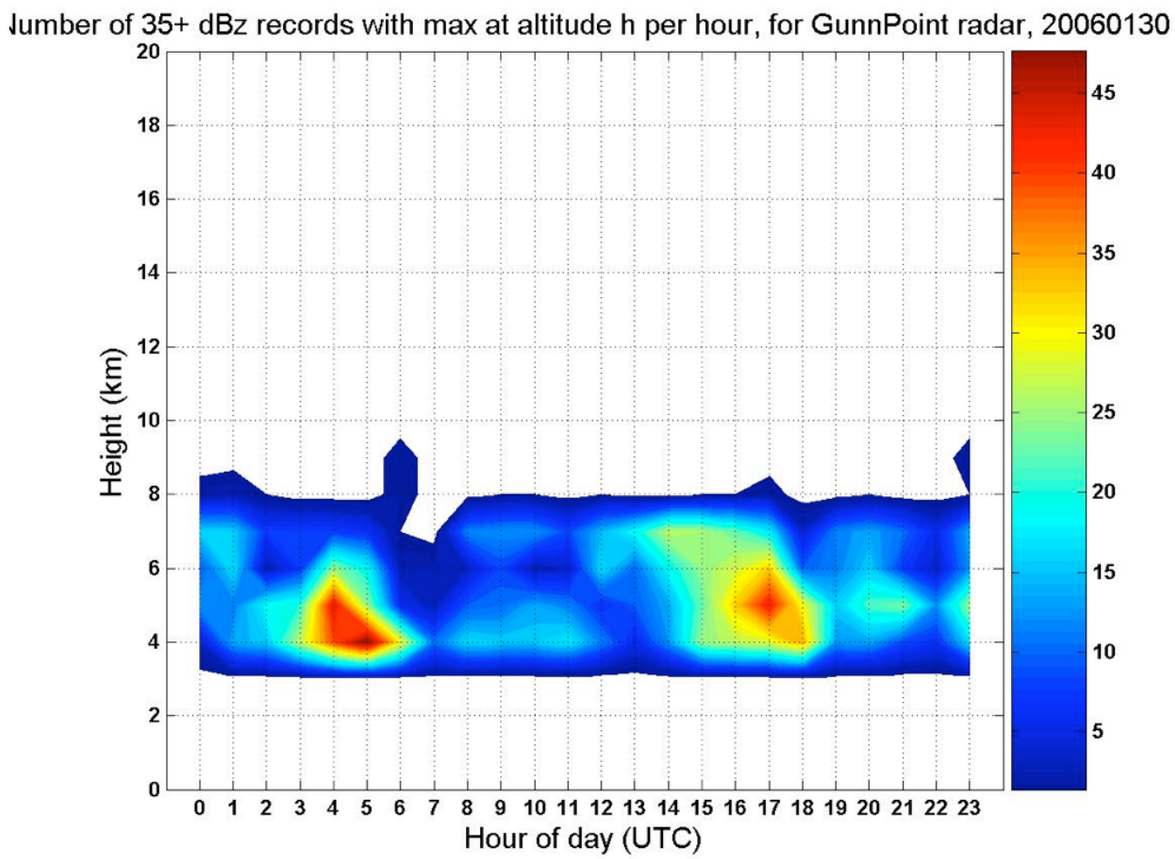
Shallow case - 30 Jan 2006

z = 2.5 km

Z > 40dBz common



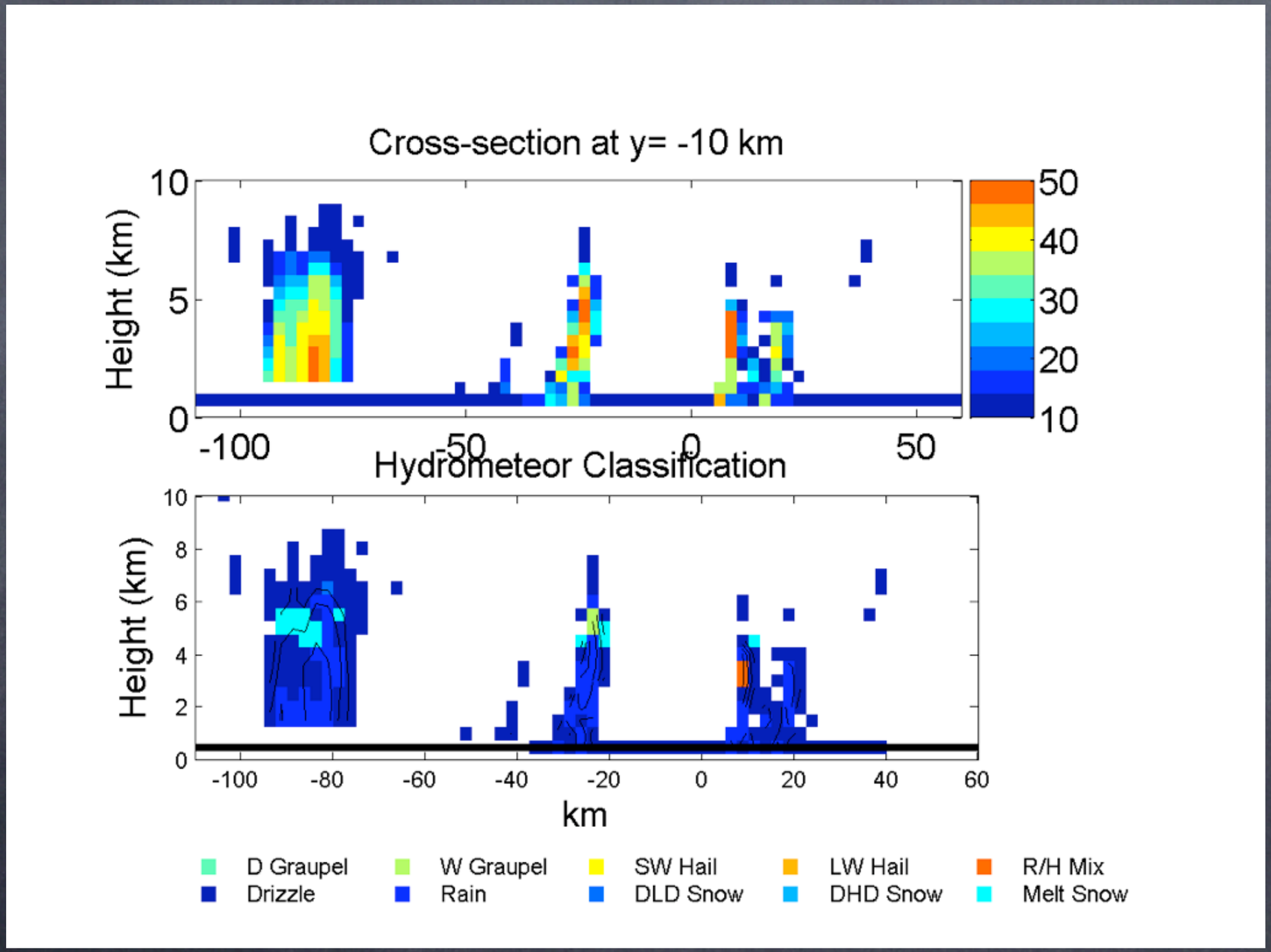
z = 6 km



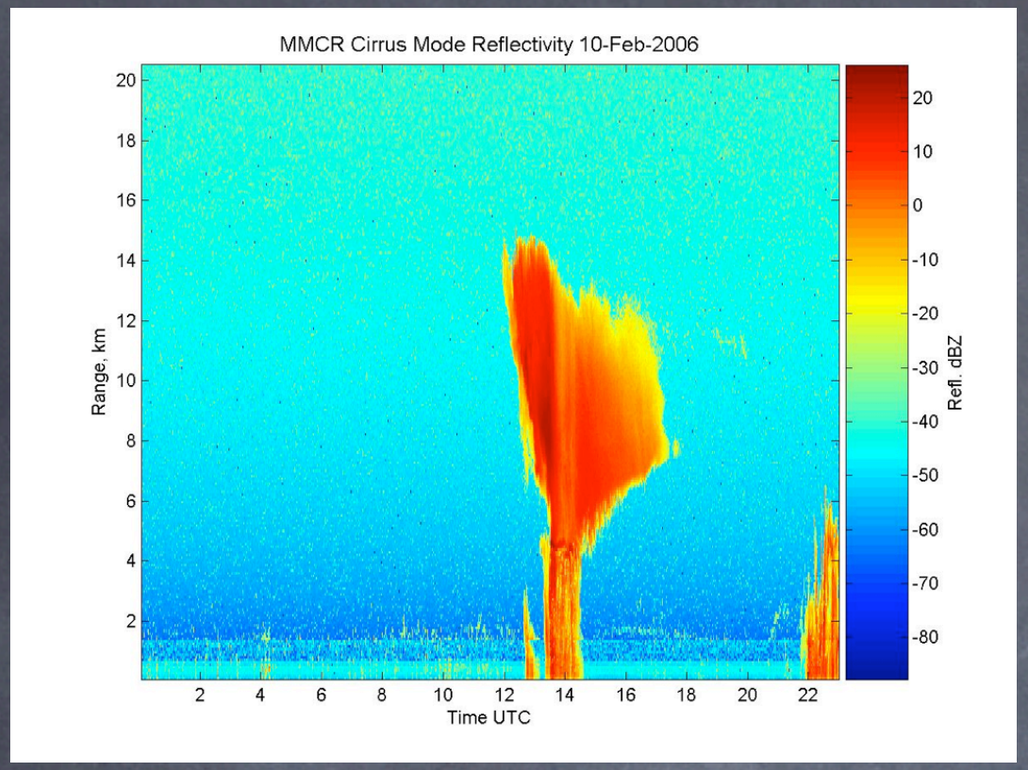
Diurnal record of number of cells with Z > 35 dBz at given height

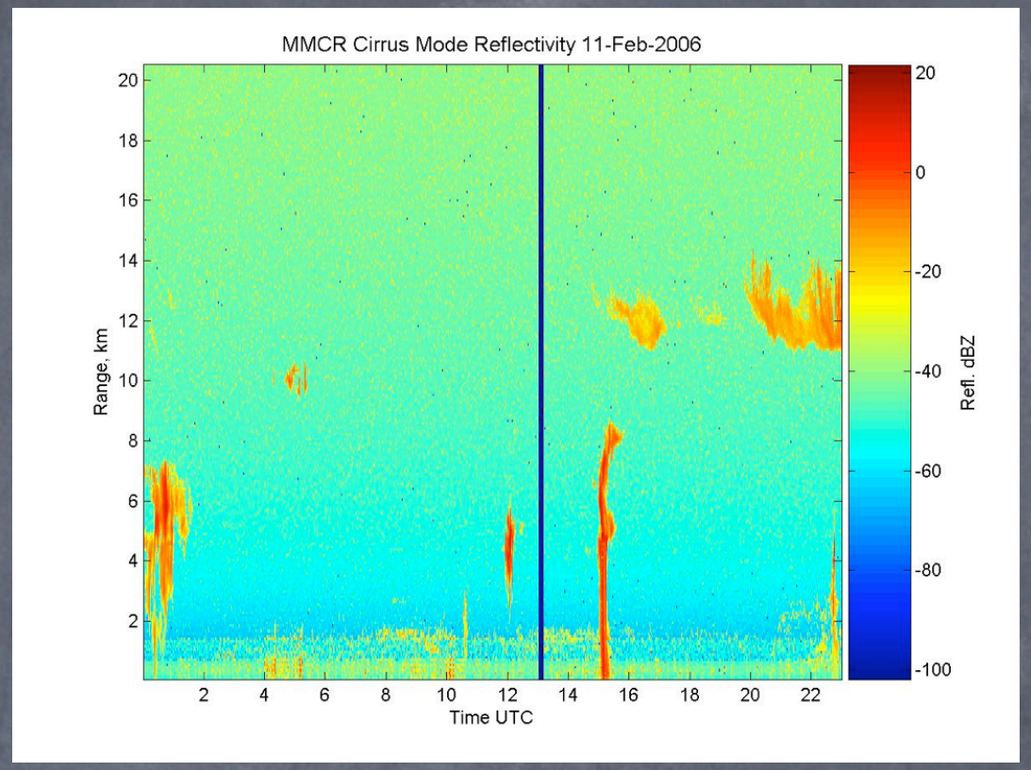
Models tend to have a hard time with this type of convection!

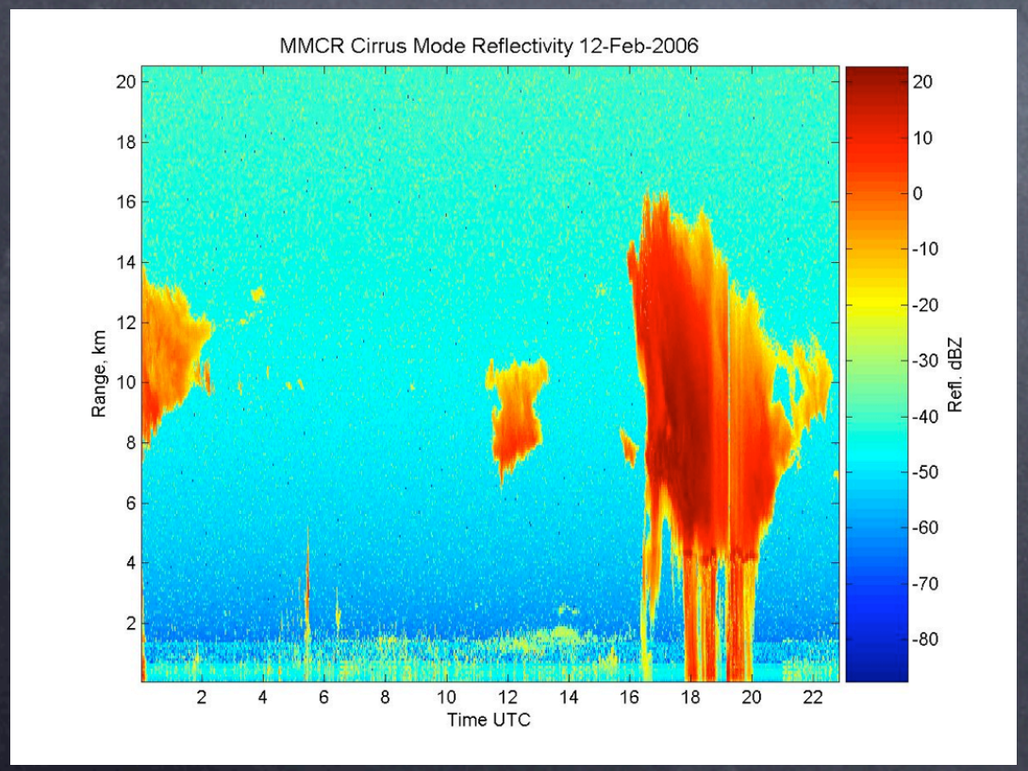
"Shallow" case - 31 January

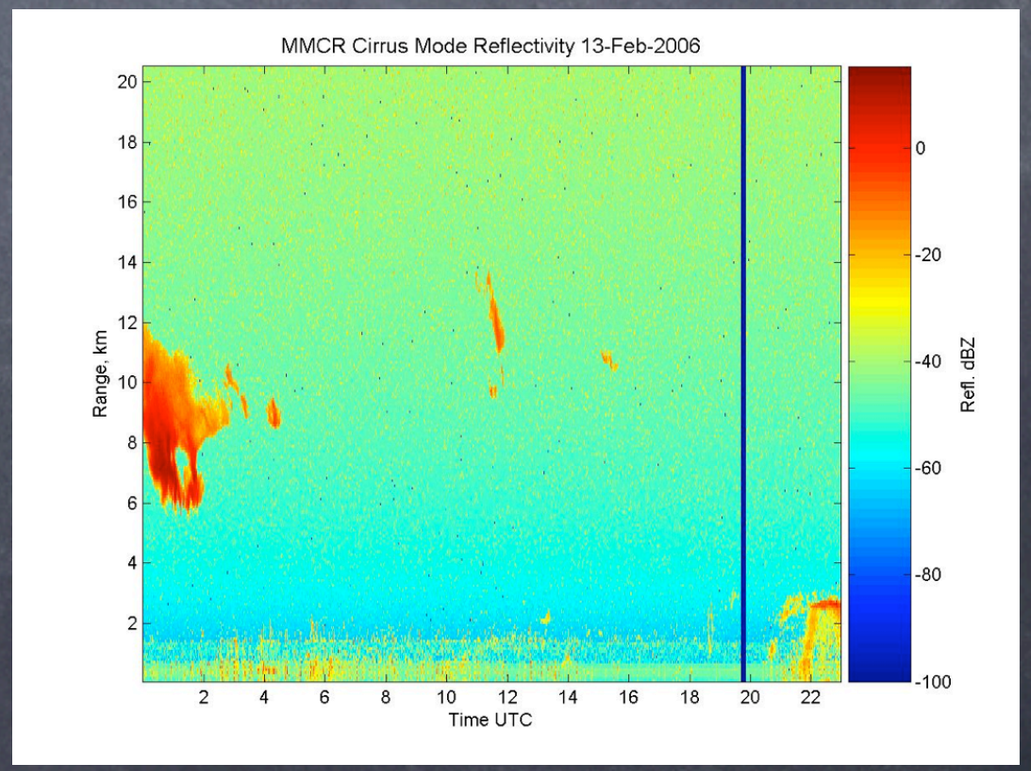


Break conditions

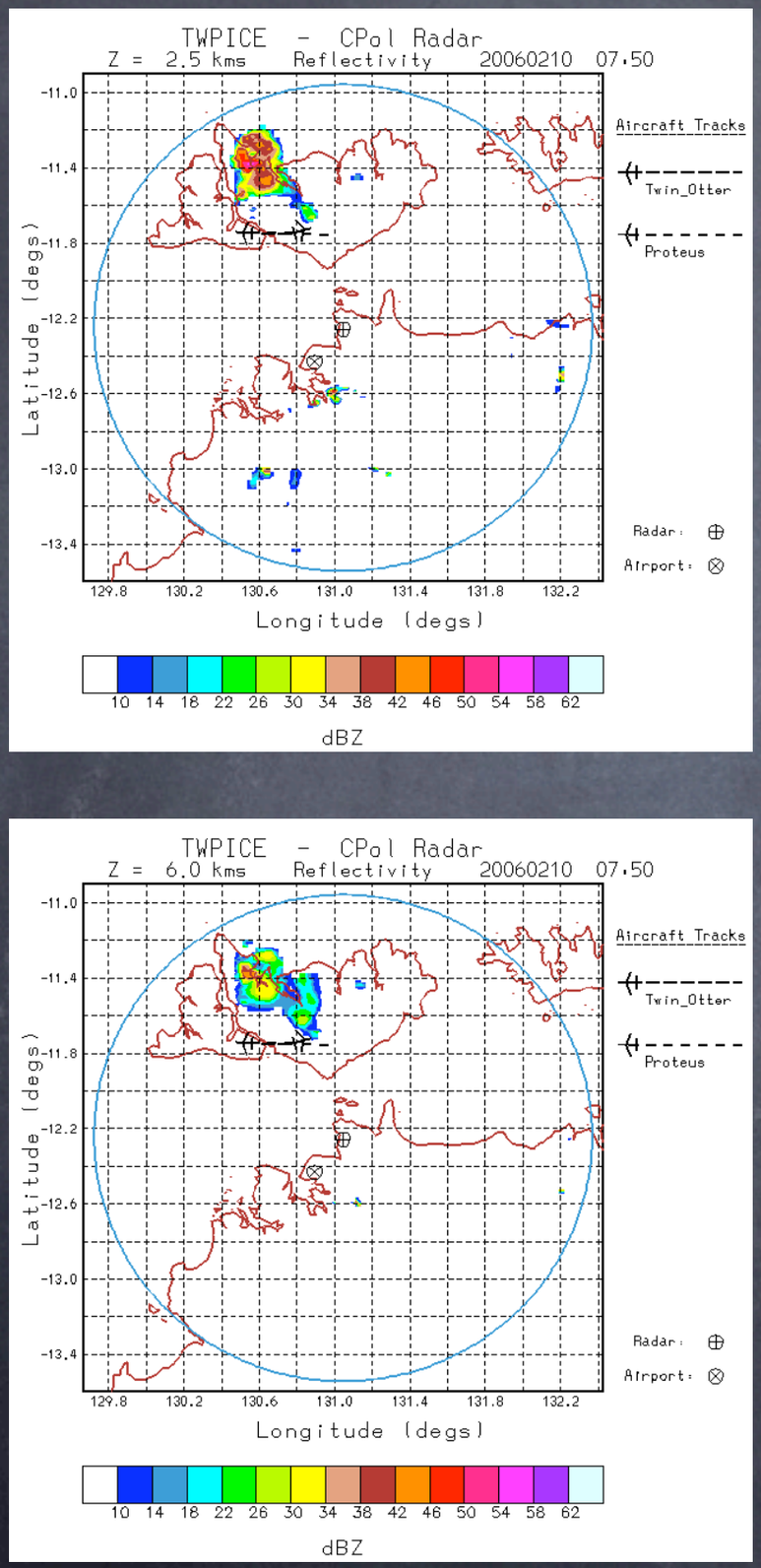

MMCR Cirrus Mode Reflectivity 10-Feb-2006
Range, km
Time UTC
Refl. dBZ

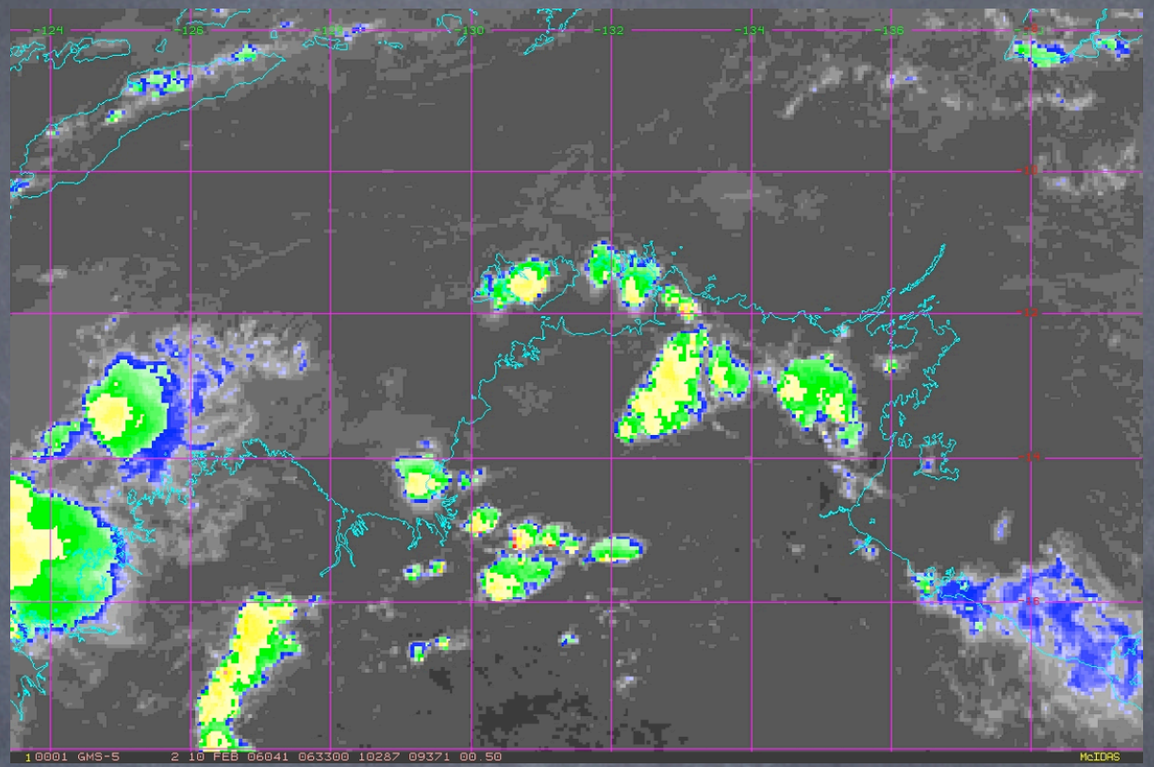

MMCR Cirrus Mode Reflectivity 11-Feb-2006
Range, km
Time UTC
Refl. dBZ

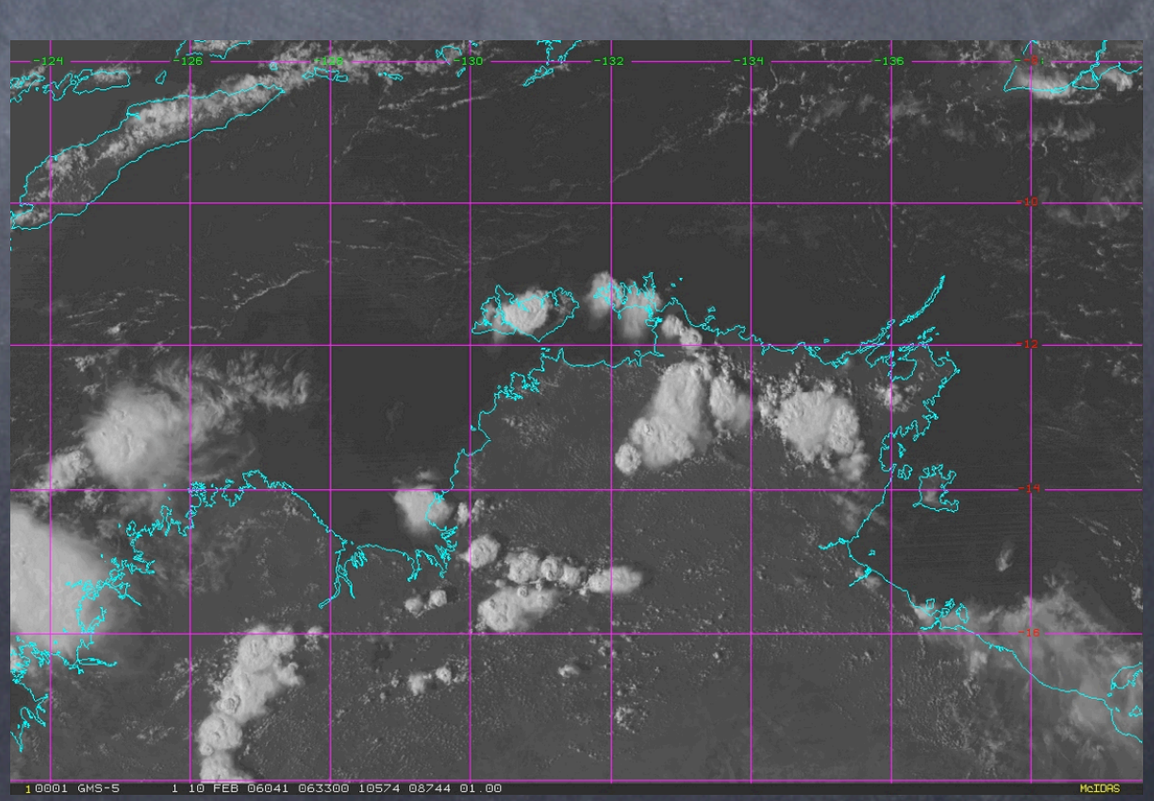

MMCR Cirrus Mode Reflectivity 12-Feb-2006
Range, km
Time UTC
Refl. dBZ


MMCR Cirrus Mode Reflectivity 13-Feb-2006
Range, km
Time UTC
Refl. dBZ

10 February - 8 UTC







Model implications

- 4 distinct phases
  - Monsoon
  - Dry monsoon (shallow clouds, heavy rain)
  - Suppressed
  - Break Conditions

Model implications

- SCM and CRM
  - concentrate on 1) Dry monsoon, 2) Monsoon, 3) Suppressed (shallow Cu from ship data?)
  - isolated topographically driven convection will be hard to capture
- High-resolution "NWP" models
  - could do break convection as priority

Forcing data

- Outcome of discussion with Steve
- Ensemble Forcing data set based on variational analysis is being developed at BMRC (Tim Hume) as part of ARM grant (2-year time scale)